Closure appliance for reagent containers

BACKGROUND OF THE INUENTION

Field of the Invention

The invention relates to an appliance for opening and closing a reagent-container stopper in a partially or fully automatic analysis apparatus, and to the method, which is applied by means of this appliance, for opening and closing a reagent-container stopper in a partially or fully automatic analysis appliance.

Description of the Related Art

Partially or fully automatic analysis apparatus are in widespread use in medical diagnostics, but also in other fields, for example in analytics. These apparatus essentially comprise three components, a reagent part, a sample part and an analysis part. A certain number of reagents are stored in reagent containers in the reagent part. The reagents must as far as possible be hermetically sealed, in order to prevent contamination and evaporation. A certain number of samples are stored in the sample part. The samples too should also be as far as possible sealed in an airtight manner, possibly for safety reasons, e.g. contamination and potential risk of infection. Furthermore, it is advantageous for the individual compartments, i.e., for example, the entire reagent part or sample part, to be protected against contamination by means of a cover. The necessary transfer of liquids between the individual parts is generally carried out by means of transfer pipettes which, depending on the particular requirements, can move in the X-, Z- and/or Y-direction and/or in the phi-direction (angular rotation). This movement is often driven by stepper motors, in which case one motor is provided for each direction of movement. Owing to the different filling volumes and the different shapes of the reagent and/or sample containers - in the following text reagent and sample containers are referred to generally as reagent containers - the maximum movement in the Z-direction is

under certain circumstances extremely great; it may be, for example, from 10 to 200 mm.

These requirements have led to various proposed solutions for the design of reagent-container stoppers. In this context, it is necessary to distinguish between two groups of solutions, on the one hand "passive" systems, in which the reagent-container stopper is designed in such a way that reclosure is to be ensured by the elasticity of the stopper material, as proposed, for example, in EP 0,509,281, and on the other hand "active" systems, in which opening and closing have to take place actively, as described, for example, in EP 0,543,638. However, this document does not provide any description of a possible solution to the question of how the above-described stopper can be opened or closed. The earlier application DE 197 46 169describes an active reagent-container stopper which is moved by means of a plunger, but this document does not describe any possible way of executing this movement. In practice, the compartment cover presents additional problems. For the reasons listed above, the reagent containers should also only be open at the moment at which the removal is taking place.

A SUMMARY OF THE INUENTION

The present invention is therefore based on the object of finding the most simple possible method for actuating an active reagent-container stopper. At the same time, the method is to be arranged in such a way that the appliances which are required for the method can, if appropriate, even be retrofitted to already existing apparatus.

This object is achieved by means of an appliance which essentially makes use of the existing vertical movement sequences of the pipette-needle carrier (4), without in doing so impairing the freedom of movement of the pipetting needle.

Advantageously, the upward movement of the pipette carrier is utilized, in that the upward movement of the pipette carrier is transmitted to the plunger (11) by means of a means which is known per se to the person skilled in the art and reverses the direction of movement, with the result that the plunger is moved downward out of the at-rest position into the working position. The utilization of the upward movement allows the plunger travel to be made independent of the immersion depth of the pipetting needle.

It is known to the person skilled in the art that, for example, forces can be transmitted in a wide variety of ways - e.g. by means of a suitable lever mechanism, a traction drive, a hydraulic appliance or a Bowden cable - so that the embodiments described below are simply intended to explain the invention, without limiting it in any way.

Brief description of the figures:

Fig. 1 shows the transfer appliance with the rocker arm mechanism in the displacement position;

Fig. 2 shows the transfer appliance in the transfer position, the pipetting-needle carrier (4) in the displacement position, and the plunger (11) in the at-rest position;

Fig. 3 shows the pipetting-needle carrier (4) in the upper position and the plunger (11) in the working position;

Fig. 4 shows the plunger (11) in the working position and the reagent-container carrier (16) in motion;

Fig. 5 shows the reagent-container stopper (13) open, the pipetting needle in the pipetting position;

Fig. 6 shows the pipetting-needle carrier (4) in the upper position and the plunger (11) in the working position;

Fig. 7 shows the pipetting-needle carrier (4) in the upper position, the plunger (11) in the working

position, and the reagent-container stopper (13) closed, the catch (15) elastically deflected;

Fig. 8 shows the transfer appliance of Fig. 1 pivoting into the displacement position, the pipetting-needle carrier (4) in the displacement position, the plunger (11) in the at-rest position;

Fig. 9 shows the transfer appliance with the toothed belt (26) in the transfer position, the pipetting-needle carrier (4) in the upper position and the ram (11) in the working position;

Fig. 10 shows the transfer appliance in the displacement position, the pipetting-needle carrier in the displacement position and the thrust plate (27) in the at-rest position;

Fig. 11 shows the reagent-container stopper (13) open, the pipetting needle in the pipetting position, the plunger (11) in the at-rest position;

Fig. 12 shows the reagent-container stopper (13), dismantled into reagent-container stopper lid (14) and reagent-container stopper body (19);

Fig. 13 shows the reagent container (12) with reagent-container stopper (13) open;

Fig. 14 shows the reagent container (12) with reagent-container stopper (13) closed.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

One embodiment of the transfer appliance according to the invention is described by way of example in Figs. 1 to 8:

1) the pipetting needle (3), which is suspended from a bearing arm (2), is moved into a position above the opening in the reagent container (12), which at this time is still closed;

2) the pipetting-needle carrier (4) is moved upward out of the displacement position, and in the process the movement is transmitted, via the catch (7), the rocker arm I (8), the stop rod (9) and the rocker arm II (10), to the plunger (11), which as a result is moved out of the at-rest position into the working position;

3) as a result of the horizontal movement of the reagent container relative to the plunger, ~~via the catch (15)~~, the lid of the reagent-container stopper is opened via the catch (15) and the reagent container is moved into the removal position;

4) as a result of the downward movement of the pipetting-needle carrier (4), in the reverse of the movement from step 2, plunger (11) is moved back into the at-rest position by means of spring force;

5) the pipetting needle (3) removes the transfer material;

6) the subsequent upward movement of the pipetting-needle carrier (4) results in the movement sequence from step 2 being repeated, with the result that plunger (11) is moved out of the at-rest position into the working position,

7) as a result of suitable movement of the reagent container relative to the plunger, the lid of the reagent-container stopper is closed by means of the catch (15), and the reagent container is moved into an at-rest position;

8) the transfer device is now ready for the next transfer operation.

Figures 9 and 10 show ~~a further~~ an alternative advantageous configuration of the transfer appliance according to the invention. In a similar manner to the exemplary embodiment described above, in this embodiment the movement of the toothed belt (26), which moves the pipetting-needle carrier (4), is utilized in order to move the plunger (11).

Further embodiments are described in the patent claims.

The pipetting-needle carrier (4) is moved upward out of the displacement position, and in the process the movement is transmitted, via the catch (7) and a thrust plate (27), to the plunger (11), which consequently is

moved out of the at-rest position into the working position.

The use of a thrust plate allows even a plunger which is at a three-dimensional distance from the removal position to be moved, so that consequently there is a greater degree of freedom in the design of the actual embodiment of the invention.

The reagent-container stoppers may be designed in many ways. For example, EP 0,543,638 describes reagent-container stoppers which are opened by a rocker mechanism which can be moved by the plunger (10) according to the invention. DE 197 46 169 describes reagent-container stoppers which are essentially distinguished by the fact that the lids can be pivoted upward and sideways by means of an inclined, bistable hinge.

It is advantageously also possible to use, for example, the two-piece reagent-container stoppers illustrated in Figures 9 to 11. The reagent-container stopper (13) comprises a reagent-container stopper lid (14) and the reagent-container stopper body (19). The two parts are connected to one another by means of a coupling pin (20). The material used is advantageously a partially elastic plastics material, such as for example polypropylene for the reagent-container stopper lid (14) and polyethylene for the reagent-container stopper body (19). The substantially horizontal movement of the lid in a single plane allows this reagent-container stopper to be of very simple structure. The opening (21) is advantageously sealed by the lid (22) by designing the seal (21/22) in the shape of a segment of a sphere.

A particularly well-sealed closure of the lid can be achieved if a lug (23) is arranged on the lid, which

lug runs in a guide (24) and thus ensures a pressure-loaded seal between the lid and the opening (21).

The advantageous design of the seal in the shape of a segment of a sphere makes it possible to dispense with a special sealing insert.

The reliability of the analysis results can be visually improved still further by means of the reagent-container stopper according to the invention by providing the reagents which are required for a specific detection with reagent-container stoppers which are of the same color.

Figs. 12 and 13 show the reagent container with the reagent-container stopper according to the invention in the open and closed positions, respectively. While the reagent-container stopper may be made from one or more different plastics materials, the reagent container itself is preferably made from a transparent plastics material or glass. It is particularly advantageous for it to be possible for reagent vessels of different designs to be closed using the same reagent-container stopper according to the invention and to be inserted into an automatic analyzer in this way.

The reagent-container stopper is opened and closed by the plunger (11), which moves relative to the reagent container, engages on a catch (15) arranged on the stopper which is to be opened and opens the lid at a predetermined position. The plunger (11), which causes the reagent-container stopper to open and close, can be actuated by the appliance according to the invention. The catch (15) is preferably designed in such a way that, in the limit position, it can be elastically deflected so far by the plunger that the plunger (11) can be moved beyond the limit position on the reagent container.

List of reference numerals:

(1) rotatable support column
(2) bearing arm
(3) pipetting needle
(4) pipetting-needle carrier, vertically movable
(5) vertical guide for the pipetting-needle carrier (4)
(6) abutment
(7) catch
(8) rocker arm I
(9) stop rod
(10) rocker arm II
(11) plunger
(12) reagent container
(13) reagent-container stopper
(14) reagent-container stopper lid
(15) partially elastic catch
(16) reagent-container carrier, horizontally movable
(17) guide for the reagent-container carrier
(18) restoring spring
(19) reagent-container stopper body
(20) coupling pin
(21) bottom shell of the seal, in the shape of a segment of a sphere
(22) top shell of the seal, in the shape of a segment of a sphere
(23) guide lug
(24) guide
(25) bar code
(26) toothed belt
(27) thrust plate
(28) thrust-plate abutment